

polymer and wherein said insulating material shows no heterogeneity on a scale of 0.1 μm , as observed under scanning electron microscopy.

REMARKS

It is respectfully requested that this application be reconsidered in view of the above amendments and the following remarks and that all of the claims remaining in this application be allowed.

Amendments

At the outset, the amendments made herein are requested to place the claims, directed to what is believed to be allowable subject matter, in better condition for appeal. Applicants specifically reserve the right to file one or more continuation/divisional applications to present claims directed to the canceled subject matter.

Amendments to the Claims

Claim 1 has been amended to more clearly point out that the product of the method is an insulating material and to include the recitation that the claimed insulating polymer shows no heterogeneity on a scale of 1 micron

Claim 7 has been amended to more clearly point out that the conducting polymer is being limited to certain types of conducting polymers.

Claims 11-14 have been amended to change the dependency to Claim 16.

Claim 16 has been amended to include the recitations that the claimed insulating polymer contains 10 to 5000 ppm of conducting polymer and that the material shows no heterogeneity on a scale of 1 micron. Support for this amendment can be found at least on page 2 lines 8 to 16 of Applicants' specification.

Claim 17 has been canceled and the limitations incorporated into Claim 16.

A marked-up version of the claims is attached hereto as Appendix A.

A complete copy of the currently pending claims is attached hereto as Appendix B.

Rejection Under 35 U.S.C. §112, first paragraph

Claims 16-18 and 11-14 have been rejected for containing subject matter that was not described in the specification in such a way as to reasonably convey to one skilled in the art

that Applicants had possession of the claimed invention. This rejection is obviated, in part, based on the previous amendments and traversed, in part, for the reasons that follow.

Claim 14, which depends on Claim 16, was rejected because the Office Action alleges that the specification failed to teach one of ordinary skill in the art how to measure heterogeneity. This rejection is traversed for the following reasons.

Claim 16 has been amended to include the recitations that the claimed insulating material contains 10 to 5000 ppm of conducting polymer and to more clearly point out that the insulating material shows no heterogeneity on a scale of 0.1 μ m. Applicants' specification clearly points out (at least on page 4 lines 22-30; example 1 on page 7 lines 9-11; example 2 on page 8 lines 21-23) the required homogeneity and the methods used to obtain that homogeneity.

The Office Action alleges that the SEM methods recited in this portion of the specification are non-enabled. Applicants note, however, that SEM methods for determining sample roughness and/or heterogeneity are so commonly used, determining the proper magnifications and resolutions for the SEM instrument and the sample are trivial optimization steps that would be known to a skilled artisan. The skilled artisan, Applicants submit in this case, is a highly educated scientist or engineer, typically at a PhD level, trained in instrumentation. In addition, if told that a sample demonstrated no heterogeneity on a 0.1 μ m scale the same person would understand that the sample in question would appear homogenous when viewed at a 0.1 μ m scale and but would then display increasing heterogeneity if viewed at much higher magnifications (i.e. as smaller and smaller features of the material are being viewed) .

Reconsideration and withdrawal of this rejection is earnestly solicited.

Claim 17 recites "a copolymer containing at least one conjugate system" which the Office Action says is not clearly defined in the specification. However Applicants note that the definition presented on page 3 lines 13-22 defines the conducting polymer (also called the conjugate polymer, see page 2 lines 15 - 16) as "a polymer having a π system of electrons relocated on at least 7 atoms on the main chain of the polymer". One example of a conducting polymer given in the same paragraph is "a copolymer containing at least one conjugate system". Applicants submit this is a clear and sufficient definition and that one of ordinary skill in the art would recognize that the copolymer needs only to contain "a region of π system of electrons relocated on at least 7 atoms", regardless of whether the copolymer

is a block copolymer or a mixed copolymer. Withdrawal of this rejection is requested.

Rejection Under 35 U.S.C. §102(b)

Claims 11-14 and 16-18 stand rejected under 35 U.S.C. §102(b) over Han *et al.* (U.S 5,254,633).

Claims 9-14 and 16-18 stand rejected under 35 U.S.C. §102(b) over Conn *et al.* (WO/9621694).

As amended independent claims 1 and 16 are drawn to insulating materials having improved resistance to thermal ageing and a method of making said insulating materials, wherein the insulating material comprises 10 to 5000 ppm of conducting polymer dispersed in an insulating polymer showing no heterogeneity on a scale of 0.1 μ m, as observed by scanning electron microscopy.

While the claimed material is insulating, the incorporation of very small amounts (0.001 to 0.5 % by weight) of a conducting polymer using the claimed method for impregnation and extrusion permits the formation of a highly homogeneous insulating material. The presented methods disperse the conducting polymer in the non-conductive polymer on almost a molecular scale (See page 4 lines 19 to 21). The combination of the very small amount of conducting polymer and the homogeneous mixing impart the composite insulating materials with improved resistance to thermal ageing. The materials of the present invention may be used in high-voltage devices, which require insulation from electric current and resistance to degradation when held at elevated temperatures for extended periods of time.

Contrary to the assertions made in the Office Action, improved thermal stability (and any other mechanical and/or electrical properties for that matter) is in no way a property that is inherent to materials with similar compositions. It is well-known that these types of properties are determined at a molecular level, and that different methods of preparation result in varying degrees of dispersal of the starting materials.

The cited reference, Conn *et al.*, shows a good example of this in their Figures 1 and 2 on sheet 1/3 in the drawings. The two materials depicted are of composites of identical composition that were processed at two different temperatures. The vastly different morphologies of the two composite materials result in different electrical properties of the materials. Conn *et al.* explain on page 6 line 19 to 24, that processing above the flowpoint

of the non-conductive polymer destroys the conductive network required to provide them with useful conductive materials.

A similar difference in the properties of the claimed insulating composite materials, when compared to insulating composite materials that are formed from non-conducting polymer particles that are either simply coated with conducting polymer or that are mixed with powdered conducting polymers.

Applicants teach methods for making non-conducting granules impregnated with a very small amount of conducting polymer that can be processed into a composite insulating material with improved properties. Without being limited to any theory, it is expected that the conducting polymers act as an antioxidant. The polymers may work better as antioxidants than small molecules because they do not diffuse to the surface in the same way that small molecule anti-oxidants have been known to. Using very limited amounts of conductive polymer coupled with the improved mixing of the conductive polymer in the non-conductive polymer, prevents the formation of conducting composite materials.

The materials described in the cited reference, Conn *et al.*, are conductive polymers, as shown at page 3 lines 25-30 of the reference: "The ratio of conducting polymer to thermoplastic material ... is in the range of 0.1% to 20% (w/w). The electrical conductivity of the composite preferably lies in the range 0.001-50 S/cm". Generally, much higher percentages of conductive polymer are required to attain the necessary conductivity for the desired uses as described by Conn *et al.*

Contrary to the assertions of the Office Action, the conductive polymers of Conn *et al.* are not made with the same processes disclosed in Applicants' specification. The method of Conn *et al.* results in a coating, whereas Applicant's method is a method of impregnation. Conn *et al.* does not disclose or suggest impregnation or extrusion steps (or any other method) to make an insulating composite material that is homogenous at the 1 micron scale and that shows improved resistance to thermal degradation. Indeed Figures 1 and 2 as referenced above show a large degree of heterogeneity at the 100 micron scale. In addition, Conn *et al.* discloses (on page 6 lines 33 to 36) that the overall mechanical properties of the composite containing the conducting polymer are not even as good as the virgin non-conductive or thermoplastic material (PVC in this example).

In order for a reference to be considered anticipatory, each and every claim element must be claimed or disclosed. Applicants submit that Conn *et al.* does not anticipate the

present invention because it does not disclose an insulating material having improved resistance to thermal ageing. Conn *et al.* does not teach composite materials comprising the low concentration of 10 to 5000 ppm of conducting polymer dispersed in an insulating polymer **and** does not teach or suggest the a heterogeneity size of 0.1 μm or less.

Instead Conn *et al.* teaches how to make and use conductive polymers for use in such devices as pressure sensors, anti-static materials, and radar-absorbing materials. Applicants' materials could not be used in such devices because they do not have the required minimum conductivity. Likewise, the materials made by Conn *et al.* do not have the required resistance to thermal degradation or the insulating properties required for use in high-voltage devices.

With regard to Han *et al.* similar arguments are made. Han *et al.* teaches composite materials useful in a large variety of devices that require conductive or semiconductive materials (see Han *et al.* column 31 lines 12 - 45). Han *et al.* may teach compositions containing 1000 ppm of a conducting polymer coating particles of non-conductive polymers. However, the resulting material is processed into an electrically conductive composite (see Column 2 lines 62 - 68). As described above, materials that have identical compositions, can not be said to have the same mechanical or electrical properties because those properties are effected by the methods used to prepare the material. While a wide range of compositions is disclosed, all of the preferred embodiments and all of the examples have significantly higher percentages of conducting polymer, because the ultimate goal is to prepare conductive composites.

Furthermore, even if the materials of Han *et al.* were insulating materials, the reference is still not anticipatory, as it teaches that the particle size is not critical and may vary widely from 10^{-18} cm^3 to 1 cm^3 (see column 5, lines 16-27), which results in a heterogeneity on a 1 cm scale (three orders of magnitude greater heterogeneity than in Applicant's materials). In addition Han *et al.* teaches the non-conductive polymer particles are coated with the conductive polymer Column 3 lines 49-51. Applicants claim methods wherein the non-conductive granules are homogeneously impregnated with conductive polymer resulting in "near molecular mixing". As discussed earlier, without the homogeneous mixing of the conductive polymer into the non-conductive polymer there would be no improvement in thermal stability.

Finally, even if the conductive polymer of Han *et al.* could be used in high-voltage devices, the conductive polymer would not show improved thermal stability over time because they do not have the required degree of homogeneity.

Again, in order for a reference to be considered anticipatory, each and every claim element must be claimed or disclosed. Applicants submit that Han *et al.* does not anticipate the present invention because it does not disclose an insulating material having a heterogeneity size of 0.1 μm or less and improved resistance to thermal ageing.

Instead Han *et al.* teaches how to make and use conductive polymers for use in such devices as electrically conductive polymers for EMI housings; IR, RF and microwave absorbing shields; and coatings for electronic components. Applicants' materials could not be used in such devices because they do not have the required minimum conductivity. Likewise, the materials made by Han *et al.* do not have the required resistance to thermal degradation or the insulating properties required for use in high-voltage devices.

Applicants submit that neither reference is anticipatory of Applicants' invention and request withdrawal of the present rejections.

Rejection Under 35 U.S.C. §103(a)

Claims 1-10 stand rejected under 35 U.S.C. §103(a) over Han *et al.* (U.S 5,254,633) in view of Conn *et al.* (WO/9621694).

Claims 11-14 and 16-18 stand rejected under 35 U.S.C. §103(a) over Han *et al.* (U.S 5,254,633).

Claims 9-14 and 16-18 stand rejected under 35 U.S.C. §103(a) over Conn *et al.* (WO/9621694).

For the following reasons, these rejections are traversed.

The novelty of the present invention lies in the insulating composite's very high thermal stability over time, in particular in its resistance to oxidation as explained on page 2, lines 5-7. The details of the increased stability are shown in Example 1 (page 7, line 17 to page 8, line 3), Example 2 (page 8, line 24 to page 9 line 14) and Example 3 (page 9, line 31 to page 10, line 9). The state of the art for adding antioxidants to insulating polymers to increase resistance to thermal ageing at the time this invention was made involved adding molecules of fairly low molecular weight to the polymer. These molecules tended to migrate toward the outer surface of the film, and were not as successful at reducing thermal

ageing. The high thermal stability of Applicant's material is due to the combination of the 10 to 5000 ppm of the conducting polymer and of the heterogeneity size of 0.1 μm or less.

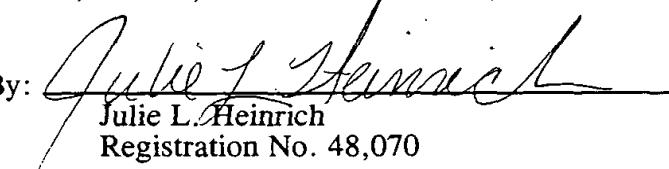
Han *et al.* teaches, as discussed above, how to make and use conductive composites made from particles that vary considerably in size and are coated with from 0.1 to 50% (w/w) conductive polymer. These composites are for use in such devices as electrically conductive polymers for EMI housings; IR, RF and microwave absorbing shields; and coatings for electronic components. It does not teach or suggest the use of any additives for improving the thermal stability of the final composite.

Conn *et al.* teaches, as discussed above, conductive composites made from a conducting polymer coated on non-conducting polymer particles in a ratio of from 0.1% to 20% (w/w), respectively. The final composite shows mechanical properties that are degraded compared to the parent thermoplastic material. It does not teach or suggest the use of any additives for improving the thermal stability of the final composite.

Each of the cited references disclose composites comprising both conductive and non-conductive materials in weight percentages that maybe similar to the weight percentage found in Applicant's insulating materials. However, neither of the references alone, or combined with the other, teaches or suggests all of the elements of Applicant's insulating composite - i.e. impregnating non-conductive polymer granules with very low percentages of conductive polymer in order to form a homogeneous insulating composite with improved resistance to thermal aging - or methods for making such a composite. For this reason the U.S. Patent And Trademark Office has not met its burden of making a *prima facie* case of obviousness. Therefor withdrawal of this rejection is respectfully requested.

Applicants submit that this application is now in condition for allowance, and a Notice to that effect is earnestly solicited. Attached hereto is 1) a marked-up version of the changes made to the claims by the current amendment and 2) a copy of the currently pending claims.

Respectfully submitted,
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APPENDIX A
Marked-Up Copy of the Claims

1. (twice amended) A method for producing insulating materials having improved resistance to thermal ageing, characterized in that it comprises the steps consisting of:

- dissolving at least one conducting polymer in an organic solvent, so as to form an impregnating solution,
- impregnating granules, formed of an insulating polymer or of a mixture of insulating polymers, with said impregnating solution,
- evaporating the solvent so as to obtain granules of insulating polymer [coated]impregnated with a conducting polymer,
- drying said granules,
- extruding or hot mixing said granules to form a homogeneous mixture,

wherein said insulating material shows no heterogeneity on a scale of 0.1 μ m as observed under scanning electron microscopy and wherein [in which] the conducting polymer represents 10 to 5000 ppm of the insulating [polymer]materials having improved resistance to thermal ageing.

7. (Twice amended) The method according to claim 6, characterized in that the conducting polymer is a conducting polymer grafted onto an insulating polymer, or is a copolymer containing at least one conjugate system.

11. (Twice amended) The material having improved resistance to thermal ageing according to Claim [17]16, characterized in that the insulating polymer is a thermoplastic resin selected from the group consisting of acrylic, styrene, vinyl resins cellulose resins, polyolefins, fluorine-containing polymers, polyethers, polyimides, polycarbonates, polyurethanes, silicones, and mixtures of homopolymers and copolymers thereof.

12. (Twice amended) The material having improved resistance to thermal ageing according to claim [17]16, characterized in that the insulating polymer is selected from the group consisting of polyethylene, low density polyethylene, high density polyethylene, linear low density polyethylene, polypropylene, ethylene-propylene-diene

terpolymer, fluorine-containing polyvinylidene, ethylene butacrylate and copolymers of ethylene and vinyl acetate, either alone or in a mixture.

13. (Twice amended) The material having improved resistance to thermal ageing according to claim [17]16, characterized in that the insulating polymer is a thermosetting resins, selected from the group consisting of polyesters, epoxy resins and phenol resins.

14. (Twice amended) The material having improved resistance to thermal ageing according to claim [17]16, characterized in that the conducting polymer has a conductivity of at least approximately 10^{-9}S.cm^{-1} .

16. (Twice amended) An insulating material having improved resistance to thermal ageing, containing 10 to 5000 ppm of a conducting polymer dispersed in or on an insulating polymer [ans]and wherein said insulating material shows no [whose] heterogeneity [size is] on a scale of $0.1\text{ }\mu\text{m}$ [or less], as observed under scanning electron microscopy.

17. (Canceled)

APPENDIX B
Currently Pending Claims

1. A method for producing insulating materials having improved resistance to thermal ageing, characterized in that it comprises the steps consisting of:
 - dissolving at least one conducting polymer in an organic solvent, so as to form an impregnating solution,
 - impregnating granules, formed of an insulating polymer or of a mixture of insulating polymers, with said impregnating solution,
 - evaporating the solvent so as to obtain granules of insulating polymer coated with a conducting polymer,
 - drying said granules,
 - extruding or hot mixing said granules to form a homogeneous mixture, wherein said insulating material shows no heterogeneity on a scale of $0.1 \mu\text{m}$ as observed under scanning electron microscopy and wherein the conducting polymer represents 10 to 5000 ppm of the insulating materials having improved resistance to thermal ageing.
2. The method according to claim 1, characterized in that the impregnation of the granules is made by dipping the latter in the impregnating solution.
3. The method according to claim 1, characterized in that the insulating polymer is a thermoplastic resin selected from the group consisting of acrylic, styrene, vinyl resins, cellulose resins, polyolefins, fluorine-containing polymers, polyethers, polyimides, polycarbonates, polyurethanes, silicones, and mixtures of homopolymers and copolymers thereof.
4. The method according to claim 1, characterized in that the insulating polymer is selected from the group consisting of polyethylene, low density polyethylene, high density polyethylene, linear low density polyethylene, polypropylene, ethylene-propylene-diene terpolymer, fluorine-containing polyvinylidene, and copolymers of ethylene and vinyl acetate, either alone or in a mixture.

5. The method according to claim 1, characterized in that the insulating polymer is a thermosetting resin selected from the group consisting of polyesters, epoxy resins and phenol resins.

6. The method according to claim 1, characterized in that the conducting polymer has a conductivity of at least approximately 10^9 S.cm^{-1} .

7. The method according to claim 6, characterized in that the conducting polymer is a conducting polymer grafted onto an insulating polymer, or is a copolymer containing at least one conjugate system.

8. The method according to claim 6, characterized in that the conducting polymer is selected from the group consisting of polythiophene, polyalkylthiopenes, polyaniline, polypyrrole, polyacetylene, polyparaphenylene, and mixtures thereof.

9. A material obtained with the method according to any one of claims 1 to 8.

10. A method of using the insulating material having improved thermal resistance obtained with the method according to any of claims 1 to 8, for the manufacture of high and/or very high voltage cables.

11. The material having improved resistance to thermal ageing according to claim 16, characterized in that the insulating polymer is a thermoplastic resin selected from the group consisting of acrylic, styrene, vinyl resins cellulose resins, polyolefins, fluorine-containing polymers, polyethers, polyimides, polycarbonates, polyurethanes, silicones, and mixtures of homopolymers and copolymers thereof.

12. The material having improved resistance to thermal ageing according to claim 16, characterized in that the insulating polymer is selected from the group consisting of polyethylene, low density polyethylene, high density polyethylene, linear low density polyethylene, polypropylene, ethylene-propylene-diene terpolymer, fluorine-containing polyvinylidene, ethylene butacrylate and copolymers of ethylene and vinyl acetate, either alone or in a mixture.

13. The material having improved resistance to thermal ageing according to claim 16, characterized in that the insulating polymer is a thermosetting resins, selected from the group consisting of polyesters, epoxy resins and phenol resins.

14. The material having improved resistance to thermal ageing according to claim 16, characterized in that the conducting polymer has a conductivity of at least approximately 10^9 S.cm^{-1} .

16. An insulating material having improved resistance to thermal ageing, containing 10 to 5000 ppm of a conducting polymer dispersed in or on an insulating polymer and wherein said insulating material shows no heterogeneity on a scale of $0.1 \mu\text{m}$, as observed under scanning electron microscopy.

18. The material having improved resistance to thermal ageing according to claim 14, characterized in that the conducting polymer is selected from the group consisting of polythiophene, the polyalkylthiopenes, polyaniline, poly-pyrrole, polyacetylene, polyparaphenylene, and mixtures thereof.